

WHAT IS CLAIMED IS:

1 1. A semiconductor device comprising:
2 a semiconductor substrate;
3 a flexible area isolated from said semiconductor substrate
4 and displaced in response to temperature change, and
5 a thermal isolation area placed between said semiconductor
6 substrate and said flexible area and made of a resin for joining
7 said semiconductor substrate and said flexible area.

1 2. The semiconductor device as claimed in claim 1, wherein the
2 material of which said thermal isolation area is made has a thermal
3 conductivity coefficient of about $0.4 \text{ W/(m } ^\circ\text{C)}$ or less.

1 3. The semiconductor device as claimed in claim 1, wherein the
2 material of which said thermal isolation area is made is polyimide.

1 4. The semiconductor device as claimed in claim 1, wherein the
2 material of which said thermal isolation area is made is a
3 fluoridated resin.

1 5. The semiconductor device as claimed in claim 1, wherein a
2 reinforcement layer made of a harder material than the material
3 of which said thermal isolation area is made is provided on at
4 least one face orthogonal to a thickness direction of said thermal
5 isolation area.

1 6. The semiconductor device as claimed in claim 1, wherein the
2 reinforcement layer has a Young's modulus of 9.8×10^9 N/m² or more.

1 7. The semiconductor device as claimed in claim 1, wherein the
2 reinforcement layer is a silicon dioxide thin film.

1 8. The semiconductor device as claimed in claim 1, wherein
2 portions of said semiconductor substrate and said flexible area
3 in contact with said thermal isolation area form comb teeth.

1 9. A semiconductor device comprising:
2 a semiconductor substrate;
3 a flexible area isolated from said semiconductor substrate
4 and displaced in response to temperature change;
5 a thermal isolation area placed between said semiconductor
6 substrate and said flexible area and made of a resin for joining
7 said semiconductor substrate and said flexible area; and
8 a moving element placed contiguous with the flexible area,
9 said moving element being displaced relative to the semiconductor
10 substrate when temperature of the flexible area changes.

1 10. The semiconductor device as claimed in claim 9, wherein the
2 flexible area has a cantilever structure.

1 11. The semiconductor device as claimed in claim 9, wherein said
2 moving element is supported by a plurality of flexible areas.

1 12. The semiconductor device as claimed in claim 11, wherein the
2 flexible areas are in the shape of a cross with said moving element
3 at the center.

1 13. The semiconductor device as claimed in claim 11, wherein
2 displacement of said moving element contains displacement rotating
3 in a horizontal direction to a substrate face of the semiconductor
4 substrate.

1 14. The semiconductor device as claimed in claim 11, wherein the
2 flexible areas are four flexible areas each shaped in L, the four
3 flexible areas being placed at equal intervals in every direction
4 with said moving element at the center.

1 15. The semiconductor device as claimed in claim 9, wherein the
2 flexible area is made up of at least two areas having different
3 thermal expansion coefficients and is displaced in response to a
4 difference between the thermal expansion coefficients.

1 16. The semiconductor device as claimed in claim 15, wherein the
2 flexible area includes an area made of silicon and an area made
3 of aluminum.

1 17. The semiconductor device as claimed in claim 15, wherein the
2 flexible area includes an area made of silicon and an area made
3 of nickel.

1 18. The semiconductor device as claimed in claim 15, wherein at
2 least one of the areas making up the flexible area is made of the
3 same material as the thermal isolation area.

1 19. The semiconductor device as claimed in claim 18, wherein the
2 flexible area includes an area made of silicon and an area made
3 of polyimide as the area made of the same material as the thermal
4 isolation area.

1 20. The semiconductor device as claimed in claim 18, wherein the
2 flexible area includes an area made of silicon and an area made
3 of a fluoridated resin as the area made of the same material as
4 the thermal isolation area.

1 21. The semiconductor device as claimed in claim 9, wherein the
2 flexible area is made of a shape memory alloy.

1 22. The semiconductor device as claimed in claim 9, wherein a
2 thermal insulation area made of a resin for joining the flexible
3 area and said moving element is provided between the flexible area
4 and said moving element.

1 23. The semiconductor device as claimed in claim 22, wherein
2 rigidity of the thermal isolation area provided between the
3 semiconductor substrate and the flexible area is made different
4 from that of the thermal isolation area provided between the
5 flexible area and said moving element.

1 24. The semiconductor device as claimed in claim 9, wherein the
2 flexible area contains heat means for heating the flexible area.

1 25. The semiconductor device as claimed in claim 9 further
2 comprising:

3 wiring for supplying power to the heat means for heating the
4 flexible area is formed without the intervention of the thermal
5 isolation area.

1 26. A semiconductor microvalve comprising:

2 a semiconductor substrate;

3 a flexible area isolated from said semiconductor substrate
4 and displaced in response to temperature change;

5 a thermal isolation area placed between said semiconductor
6 substrate and said flexible area and made of a resin for joining
7 said semiconductor substrate and said flexible area; and

8 a moving element placed contiguous with the flexible area,
9 said moving element being displaced relative to the semiconductor
10 substrate when temperature of the flexible area changes; and

11 a fluid element being joined to said semiconductor device
12 and having a flow passage with a flowing fluid quantity changing
13 in response to displacement of the moving element.

1 27. The semiconductor microvalve as claimed in claim 26, wherein
2 said semiconductor device and said fluid element are joined via
3 a spacer layer.

1 28. A semiconductor microrelay comprising:
2 a semiconductor substrate;
3 a flexible area isolated from said semiconductor substrate
4 and displaced in response to temperature change;
5 a thermal isolation area placed between said semiconductor
6 substrate and said flexible area and made of a resin for joining
7 said semiconductor substrate and said flexible area; and
8 a moving element placed contiguous with the flexible area,
9 said moving element being displaced relative to the semiconductor
10 substrate when temperature of the flexible area changes; and
11 a fixed element joined to said semiconductor device and having
12 fixed contacts being placed at positions corresponding to a moving
13 contact provided on the moving element, the fixed contacts being
14 able to come in contact with the moving contact.

1 29. The semiconductor microrelay as claimed in claim 28, wherein
2 the fixed contacts are placed away from each other and come in

3 contact with the moving contact, whereby they are brought into
4 conduction via the moving contact.

1 30. The semiconductor microrelay as claimed in claim 28, wherein
2 said semiconductor device and said fixed element are joined via
3 a spacer layer.

1 31. A manufacturing method of a semiconductor device as claimed
2 in claim 18 prepared by a process comprising the steps of:

3 etching and removing one face of the semiconductor substrate
4 to form a bottom face part as one area forming a part of the flexible
5 area;

6 etching and removing the other face of the semiconductor
7 substrate to form the concave part in the moving element;

8 etching and removing the other face of the semiconductor
9 substrate to form at least a portion which becomes the thermal
10 isolation area placed between the semiconductor substrate and the
11 flexible area;

12 filling the portion which becomes the thermal area
13 with a thermal insulation material to form the thermal insulation
14 area; and

15 applying a coat of the thermal insulation material to the
16 one face of the semiconductor substrate to form one area forming
17 a part of the flexible area.

1 32. A manufacturing method of a semiconductor device as claimed
2 in claim 16 prepared by a process comprising the steps of:
3 etching and removing one face of the semiconductor substrate
4 to form a bottom face part as one area forming a part of the flexible
5 area;
6 etching and removing the other face of the semiconductor
7 substrate to form the concave part in the moving element;
8 etching and removing the other face of the semiconductor
9 substrate to form at least a portion which becomes the thermal
10 isolation area placed between the semiconductor substrate and the
11 flexible area;
12 forming an aluminum thin film as an area defined in the
13 flexible area on the other face of the semiconductor substrate and
14 a wire for applying an electric power to the heating means;
15 filling the portion which becomes the thermal area
16 with a thermal insulation material to form the thermal
17 area.

1 33. A manufacturing method of a semiconductor device as claimed
2 in claim 17 prepared by a process comprising the steps of:
3 etching and removing one face of the semiconductor substrate
4 to form a bottom face part as one area forming a part of the flexible
5 area;
6 etching and removing the other face of the semiconductor
7 substrate to form the concave part in the moving element;

8 etching and removing the other face of the semiconductor
9 substrate to form at least a portion which becomes the thermal
10 isolation area placed between the semiconductor substrate and the
11 flexible area;

12 forming a wire for applying an electric power to the heating
13 means;

14 filling the portion which becomes the thermal area
15 with a thermal insulation material to form the thermal
16 area; and

17 forming a nickel thin film as an area defined in the flexible
18 area on the other face of the semiconductor substrate.

1 34. A manufacturing method of a semiconductor device as claimed
2 in claim 1 prepared by a process comprising the steps of:

3 etching and removing one face of the semiconductor substrate
4 to form at least a portion which becomes the thermal isolation
5 area placed between the semiconductor substrate and the flexible
6 area;

7 filling the portion which becomes the thermal isolation area
8 with a thermal insulation material to form the thermal isolation
9 area; and

10 etching and removing the other face of the semiconductor
11 substrate to form the thermal insulation area.

1 35. A manufacturing method of a semiconductor device as claimed

2 in claim 5 prepared by a process comprising the steps of:
3 etching and removing one face of the semiconductor substrate
4 to form at least a portion which becomes the thermal insulation
5 area placed between the semiconductor substrate and the flexible
6 area;
7 forming a reinforce layer in the thermal insulation area;
8 filling the portion which becomes the thermal isolation area
9 with a thermal insulation material to form the thermal isolation
10 area; and
11 etching and removing the other face of the semiconductor
12 substrate to form the thermal isolation area.